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FutureMetrics presents:

An Overview of a Risk Analysis for a Wood Pellet Manufacturing Project

This hypothetical project analysis illustrates advanced modeling techniques for identifying and quantifying risks. This example is limited in scope to feedstock, product pricing, and operational risks. Our typical project modeling extends well beyond what is presented in the following pages and includes, for example, considerations for:

- **Pellet export projects;**
 - **policy risk**
 - **currency risk**
 - **shipping cost risk**
 - **market disruption risk (the “Tilbury effect”)**
- **Torrefied pellet production;**
 - **mass and energy balance sensitivities and cost of goods risk**
 - **reliability and maintenance cost risk**
 - **market demand risk (all of the above for export plus competition from white pellets)**
- **Working capital issues;**
 - **supply chain risk**
 - **product lost risk (optimal insurance coverage)**

Dr. William Strauss, president of FutureMetrics, is the leading expert on the use of Monte Carlo simulations* in bioenergy project development and finance. He is a five time invited speaker at the annual Risk Analysis, Applications, and Training Conference (this year to be held in Las Vegas November 7 and 8, 2012). At this year’s conference he will be presenting a version of this paper expanded to include risks associated with pellet exports.

* Monte Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision making. The technique is used by professionals in a variety of fields such as finance, project management, energy, manufacturing, engineering, insurance, oil & gas, transportation, and the environment. In Monte Carlo simulation, uncertain inputs in a model are represented using ranges of possible values known as probability distributions. By using probability distributions, variables can have different probabilities of different outcomes occurring. Probability distributions are a much more realistic way of describing uncertainty in variables of a risk analysis. Monte Carlo simulation provides the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action (source: Palisade Corp.).



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Identifying Key Risks to the Development of a Pellet Manufacturing Plant

Analysis of a 50,000 ton per year pellet manufacturing facility co-located with a Combined Heat and Power plant supplying hot water for belt drying and power*

August, 2012

This analysis contains detailed financial and risk modeling for the construction and operation of a 50,000 ton per year nameplate capacity pellet factory. The operation is expected to be co-located with a combined heat and power (CHP) plant. The CHP plant would provide hot water for wood drying and electricity for the pellet plant's motors etc.

The modeling incorporates the uncertainty of some of the key inputs to both the capital cost and the operating cost models. Monte Carlo simulations reveal the expected distributions of key cash flow metrics and the sensitivity of the key cash flow metrics to changes in inputs. The analysis shows the risk of insufficient cash flows to the project developers and identifies those cost inputs and revenue generating assumptions whose changes generate the greatest risk of project failure.

Underlying the analysis is a detailed CAPEX and OPEX model.

DESCRIPTION - 50,000 TPY with Belt Dryers	
Wet product milling line	\$1,969,000
Wet product feeding system	\$208,000
Dryer system	\$688,000
Dry product intermediate storage	\$295,000
Milling and pelletizing line	\$1,229,000
Pellets storage silos	\$289,000
Bagging and palletizing line	\$296,000
Electrical equipment	\$476,000
Equipment Total	\$5,450,000
Other Costs including land, site prep, buildings, permitting, engineering, supervision, construction, equipment, spare parts, contingency	\$5,410,000
Total Capital Cost	\$10,860,000

* Disclaimer: This analysis is based on hypothetical data that is roughly based on actual project data aggregated from several real projects. However, the data and the conclusions do not represent any specific real project.



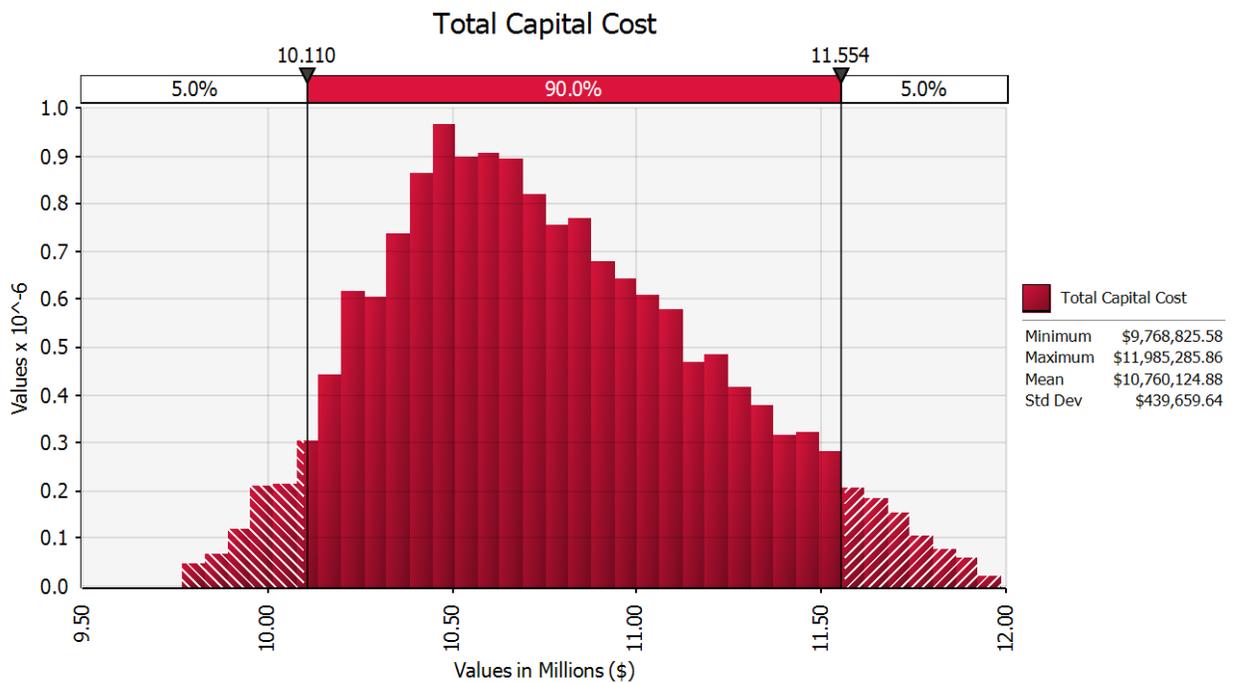
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Model Inputs

This analysis is based on a detailed model of a 50,000 tpy pellet plant using a hot water belt dryer. Many of the critical inputs to the cash flow model have inherent uncertainty. The uncertainties of those inputs are modeled with probability distributions that describe the ranges and the likelihood of the costs or production metrics to take on an actual value within those ranges. The distributions are based on historical pricing and operations data, and in some cases analyses of expected conditions.

Following are charts showing some of the key input distributions. The historical data is fitted to determine the best mathematical process for driving the sampling for each iteration of the simulation.

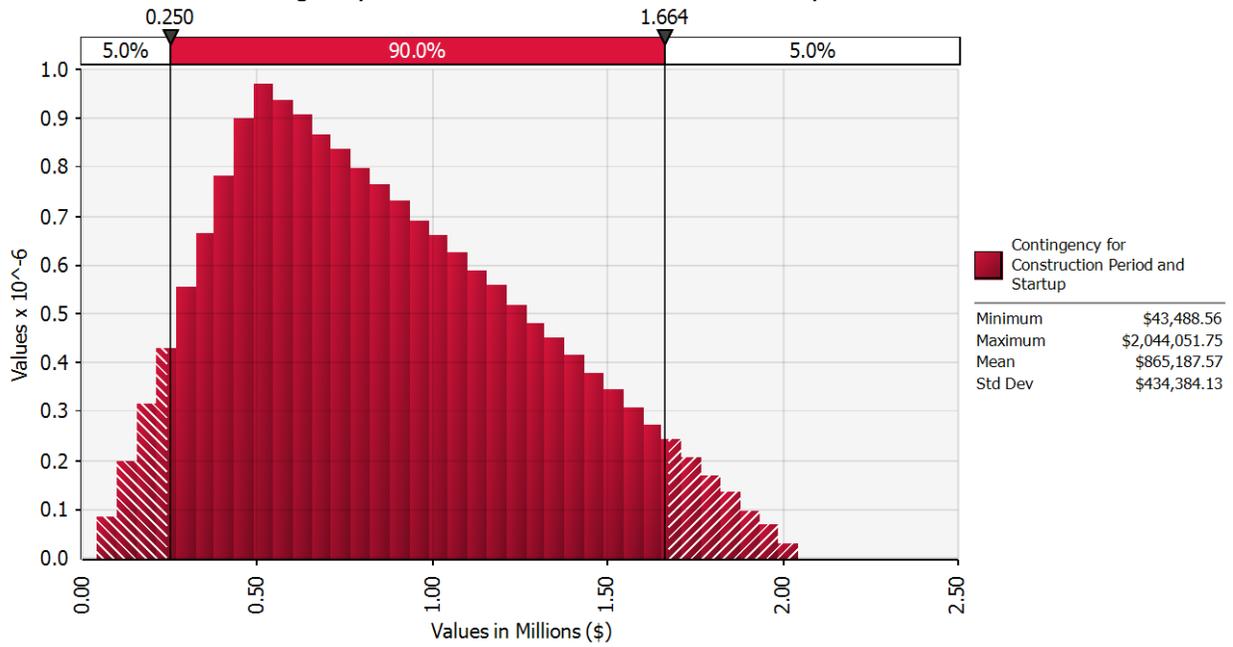




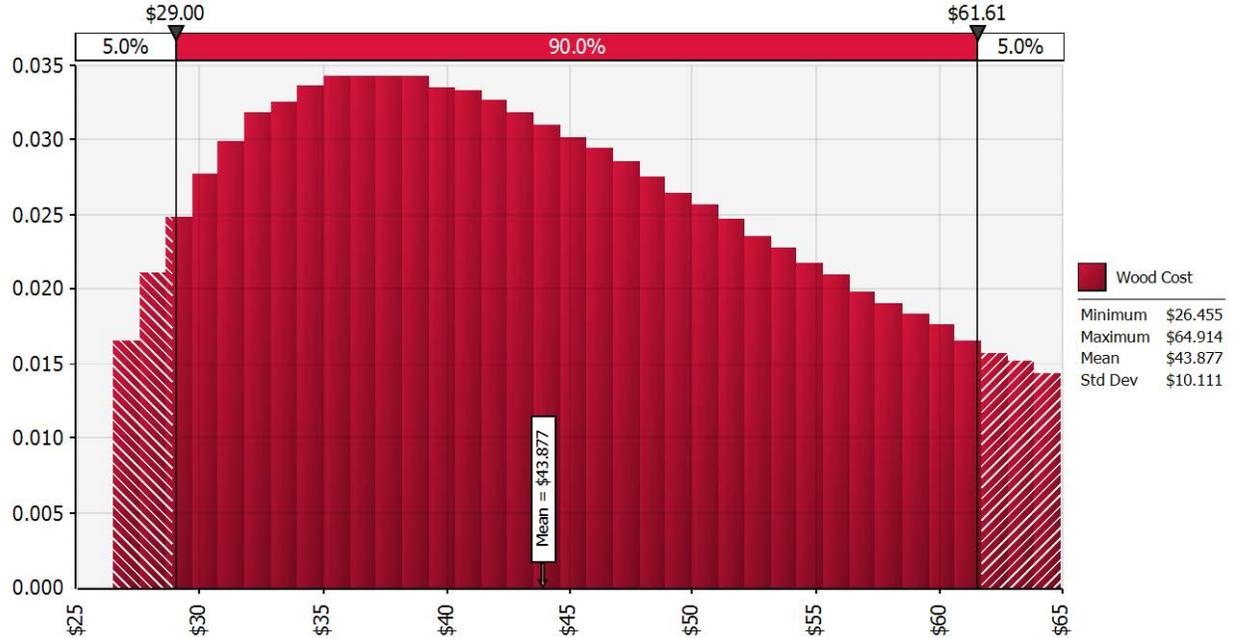
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Contingency for Construction Period and Startup



Wood Cost

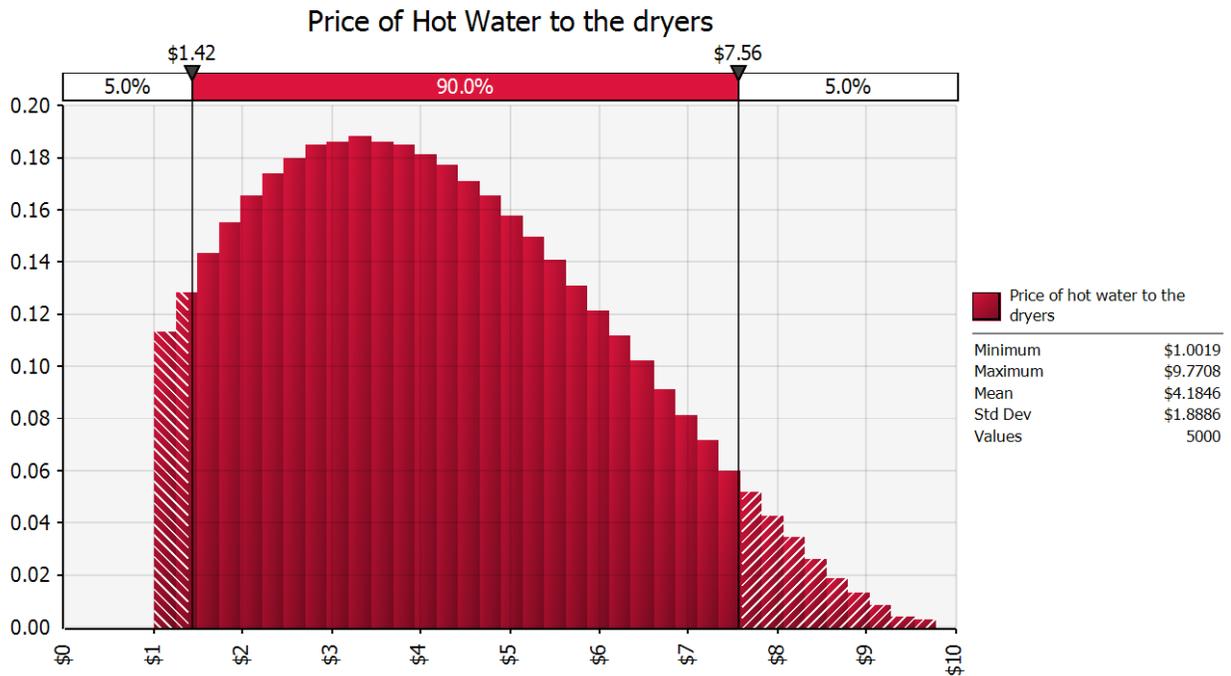
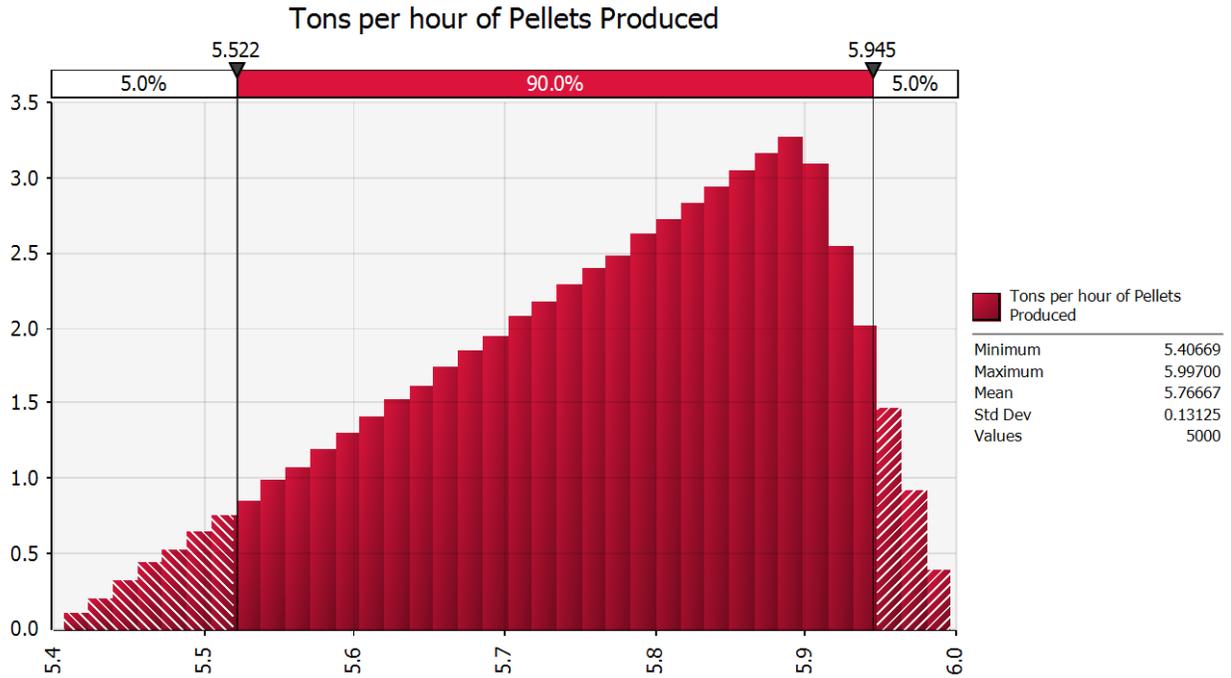


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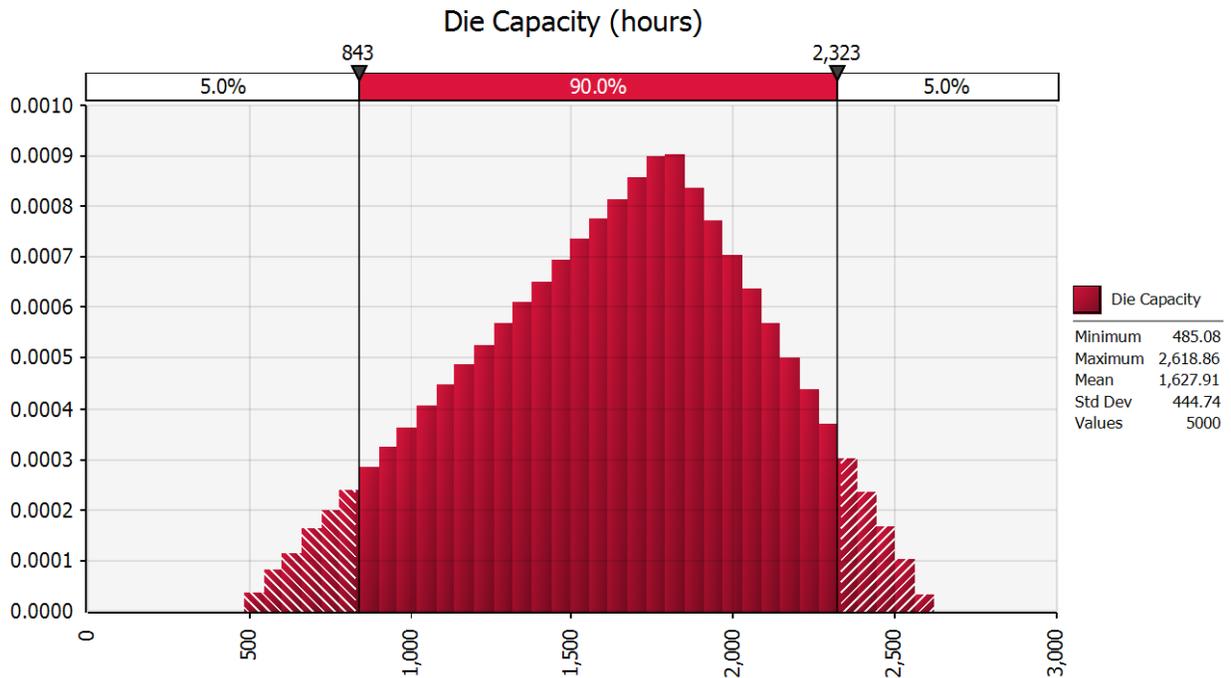
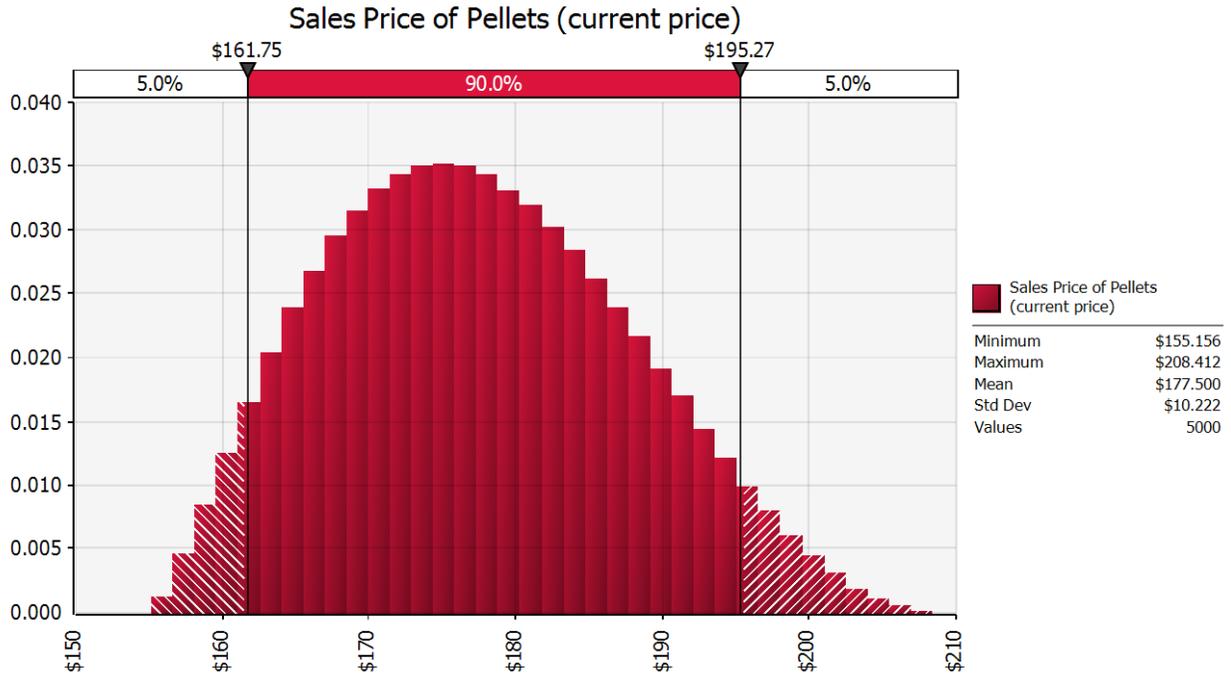


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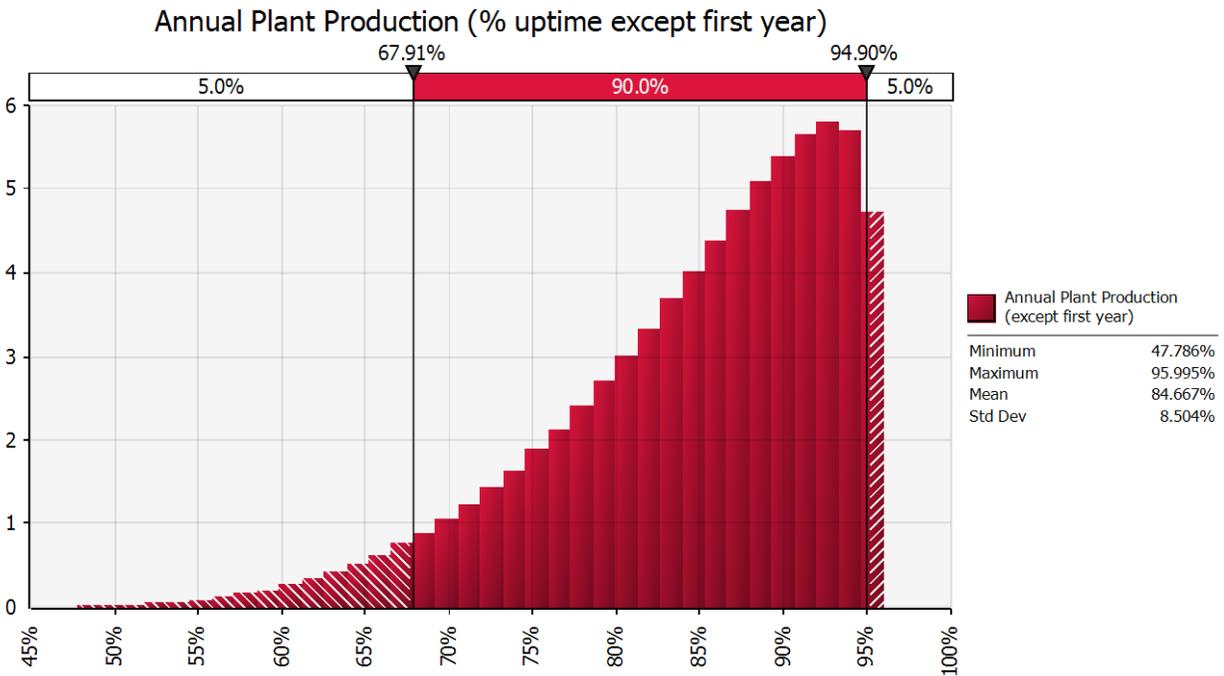
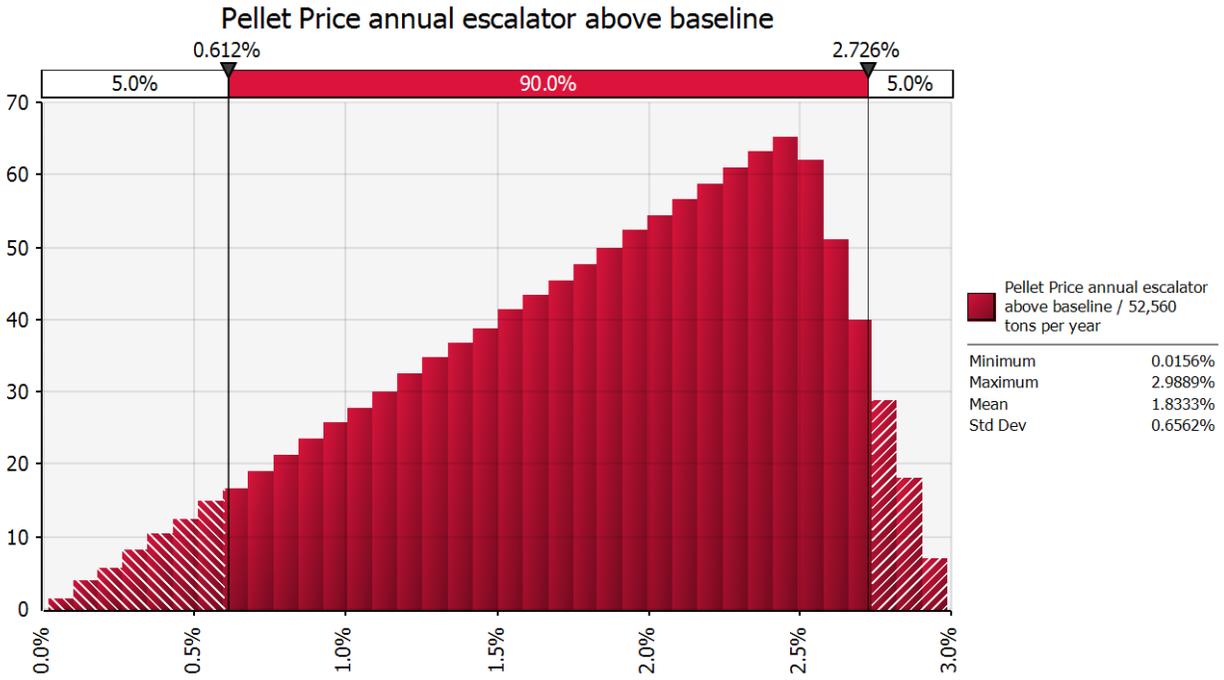


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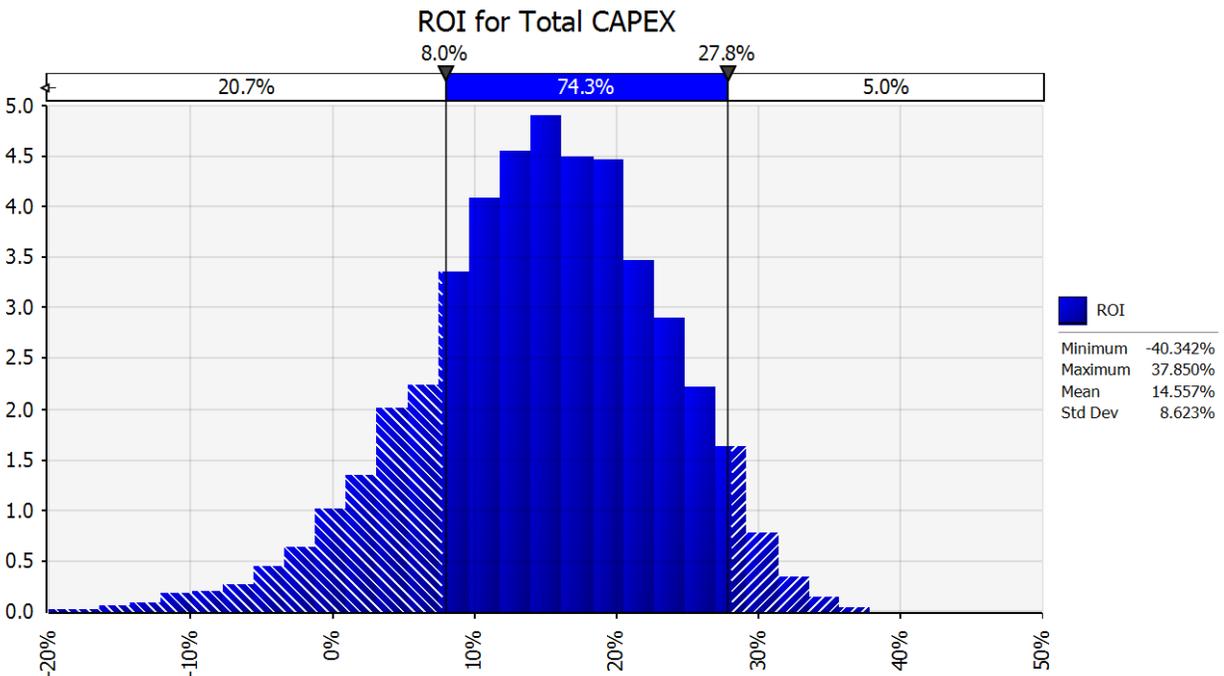
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Model Outputs

Key metrics resulting from a 5,000-iteration simulation are as follows:

The return on the total capital investment accounts for the total CAPEX including contingency as the initial cash outflow and the net operating cash flows through year 10. Net operating cash flows include all revenue and cash outflows including debt service and taxes (assumed at 30% of income before taxes).



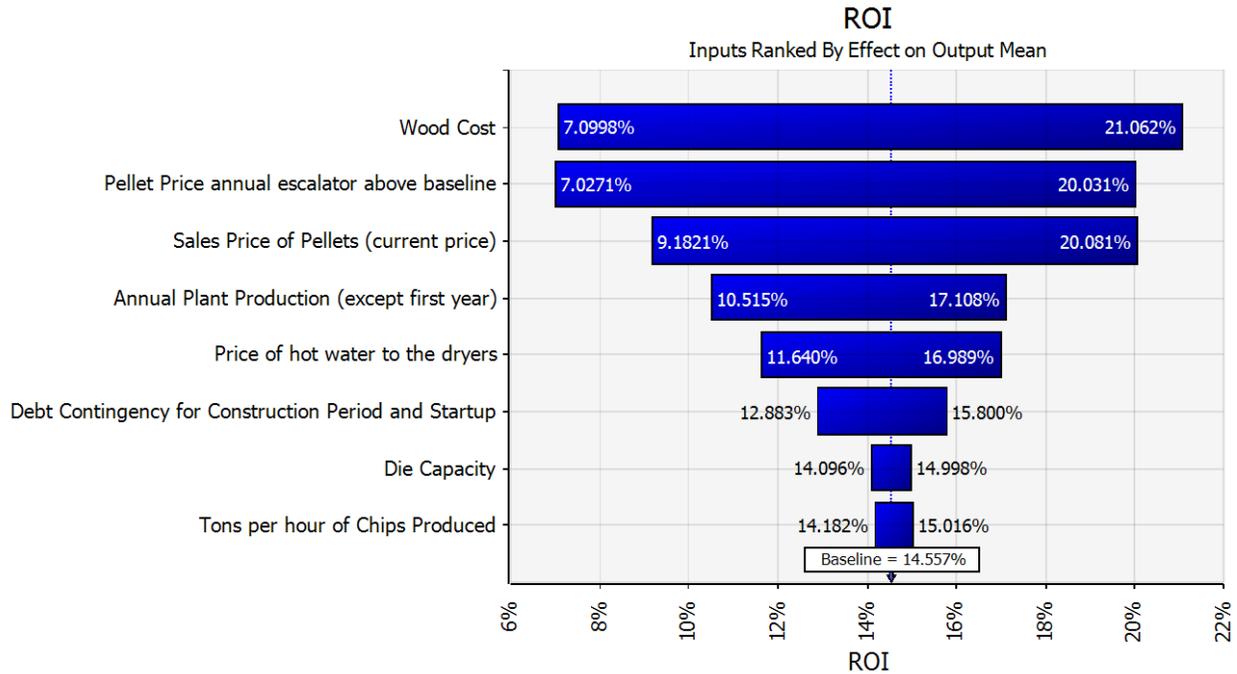
The project has a 20.7% probability of returning less than 8.0% per year on the full investment. The project has a 5.4% probability of a zero or less ROI. The expected (mean) ROI is 14.557%

The sensitivity of ROI to changes in inputs is illustrated by the following two charts. The first shows the range of the effects of the inputs on ROI. For example, the highest wood cost sampled in the simulation lowers the mean ROI to 7.1% (with all other inputs held at their expected values).



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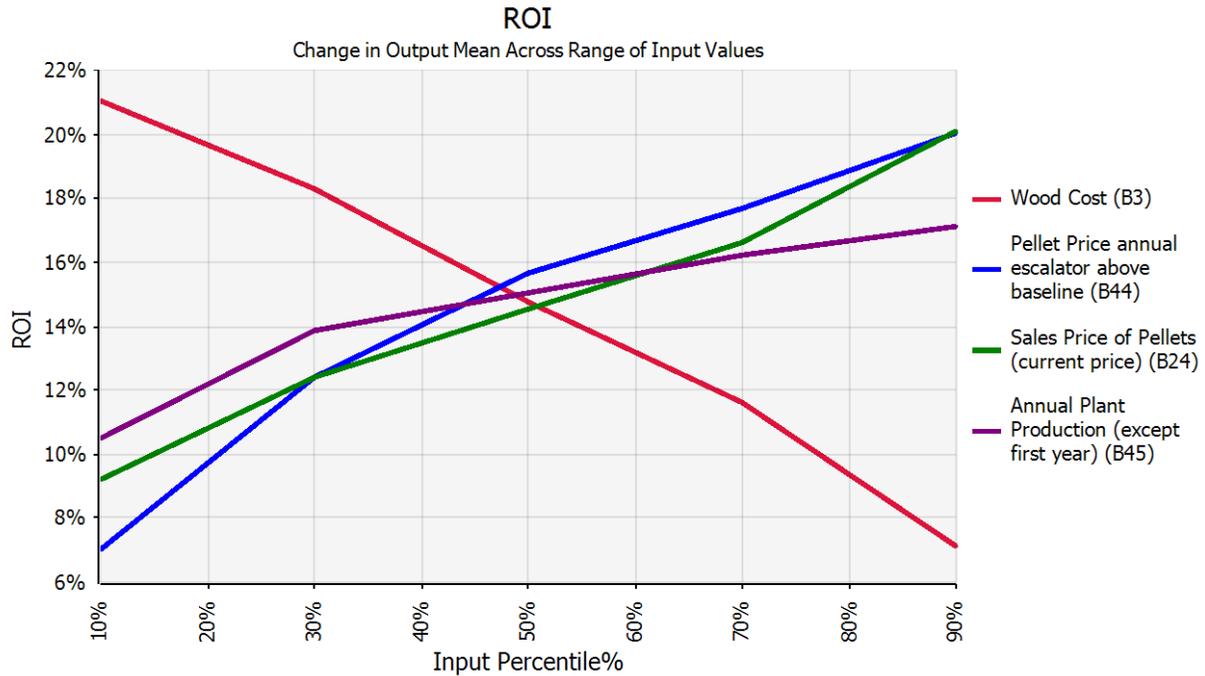
The second chart below shows the same data but also, via the slope of the lines, shows the rate of change to the ROI to changes in each of the inputs (only the top four are shown). The steeper the line the more beneficial or detrimental the input to the return on the investment for a given change in the input. The chart shows that wood cost, the ability for pellet prices to rise over the 10 year life at a rate greater than 0%, and the initial price for pellets are critical input risks that must be understood and mitigated.

Also critical to the success of the project is capacity utilization. Sizing the output of the project to the market demand is critical. Excess capacity will significantly degrade the project's expected returns. Also related to capacity utilization, plant safety (explosion and fire mitigation) and reliability (process flow and equipment selection) are critical to the success of the project.

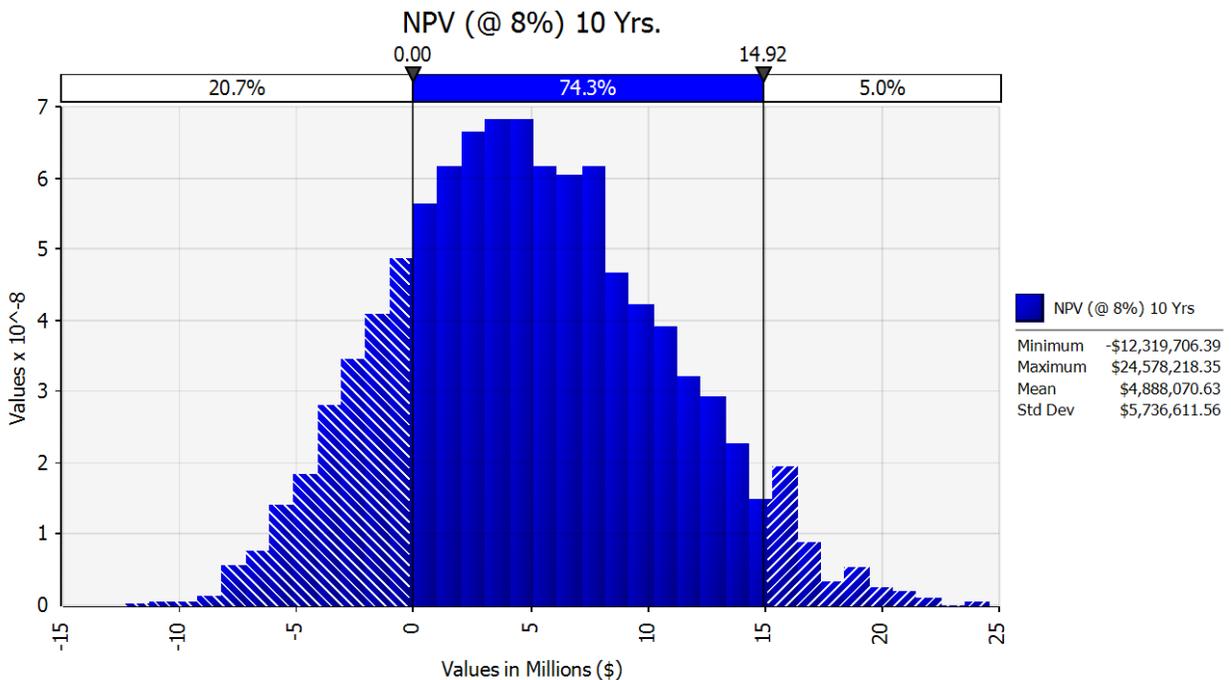


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The project's expected net present value using a discount rate of 8% over 10 years of cash flows is about \$4.9 million.



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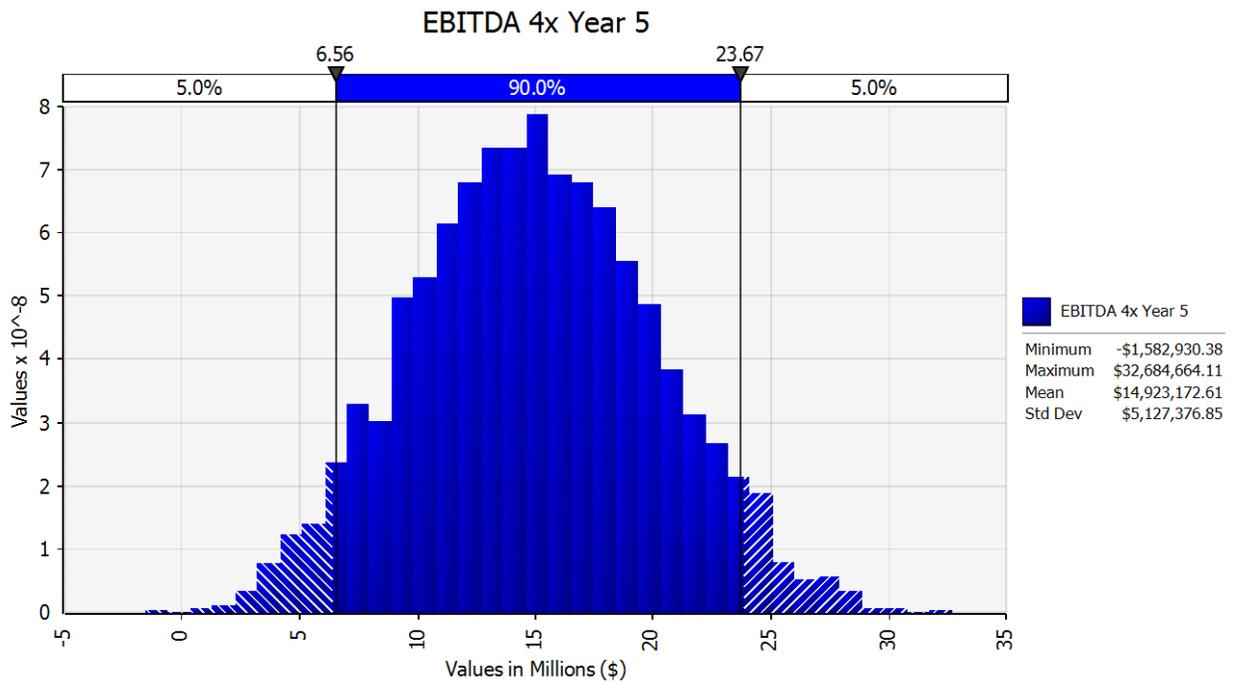
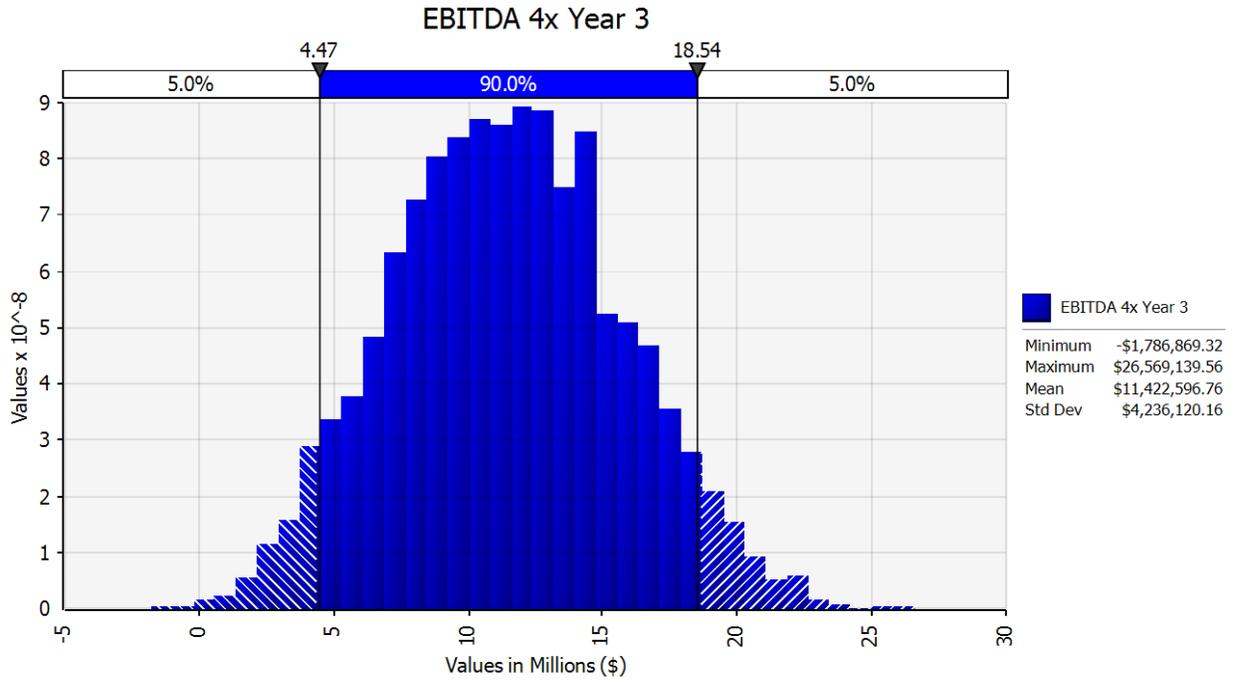


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Key metrics for investors are as follows:

The expected 4x EBITDA in year 3 and year 5 are \$11.4 and \$14.9 million respectively.



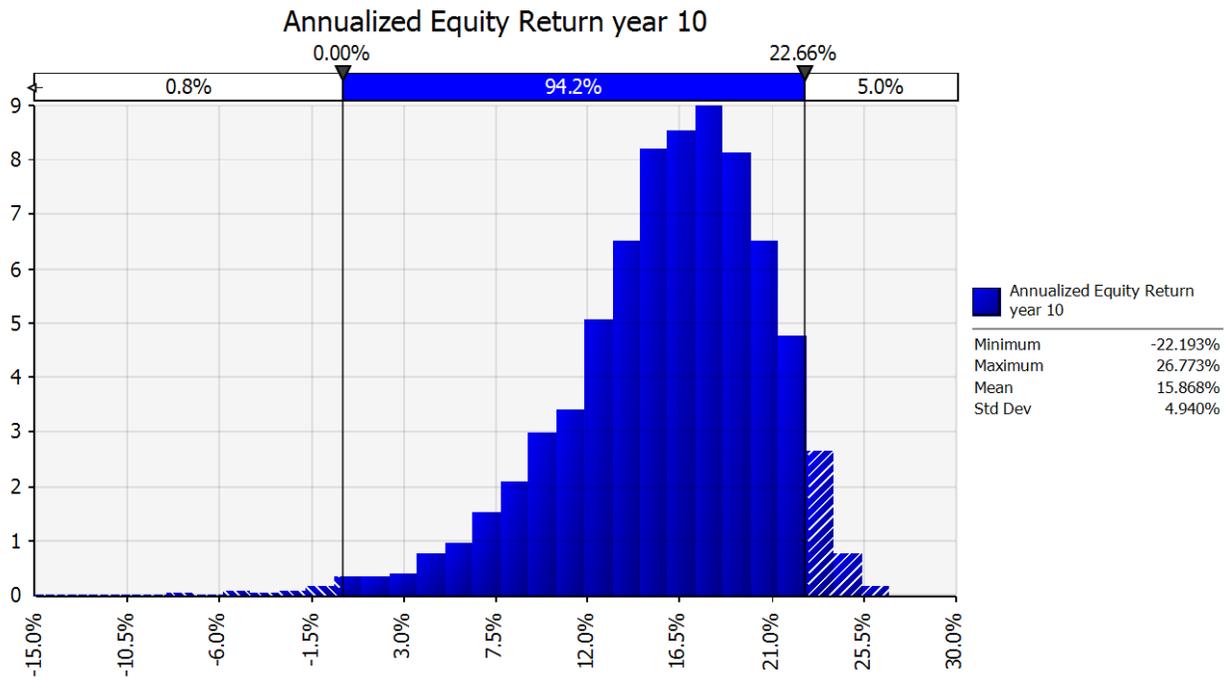
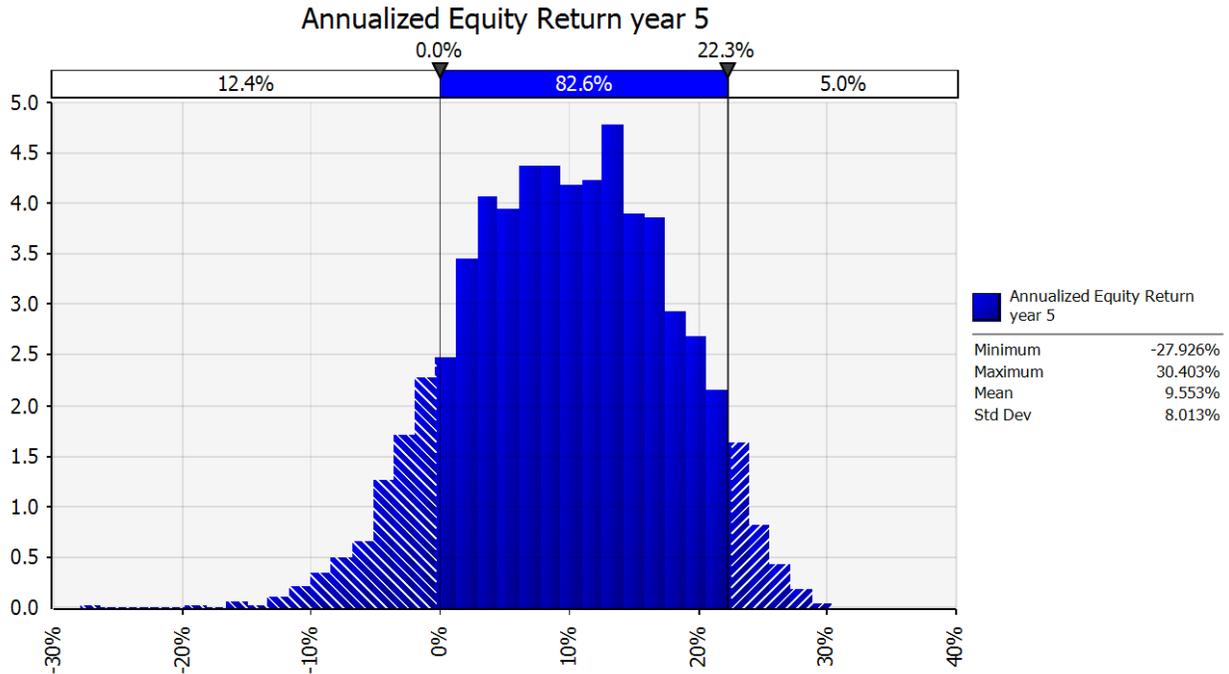
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Assuming a 50% equity and a 50% debt capital structure, the equity can cash out with an expected net annualized return of 9.55% in year 5 or a 15.87% annualized return in year 10. This is the net return from the initial equity investment.



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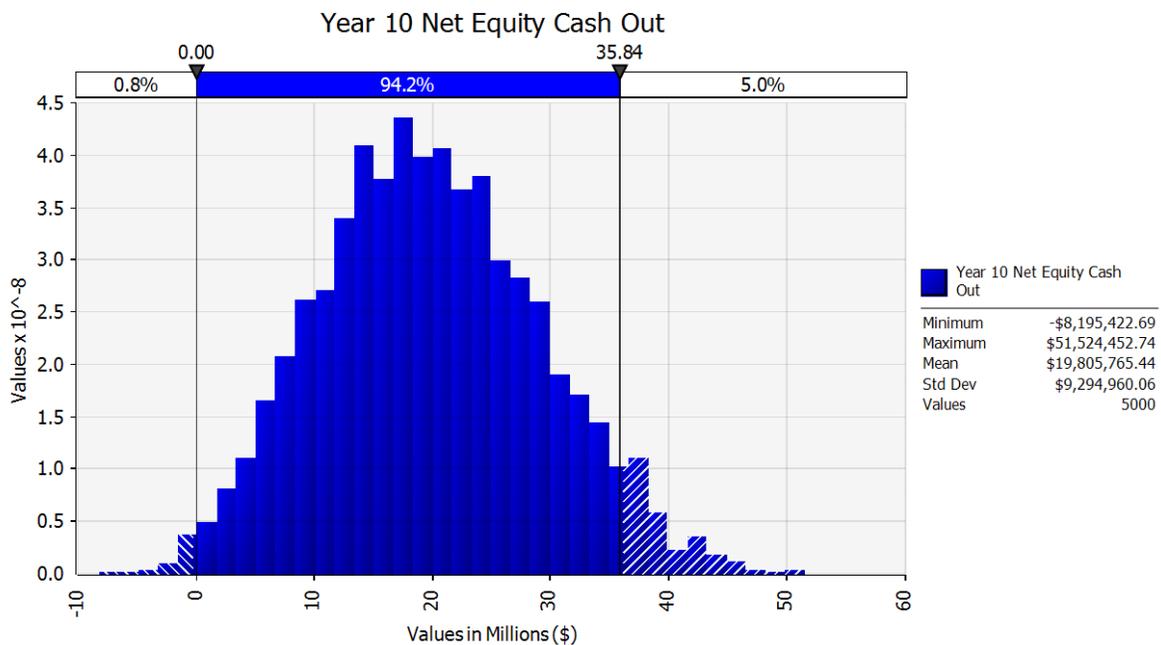
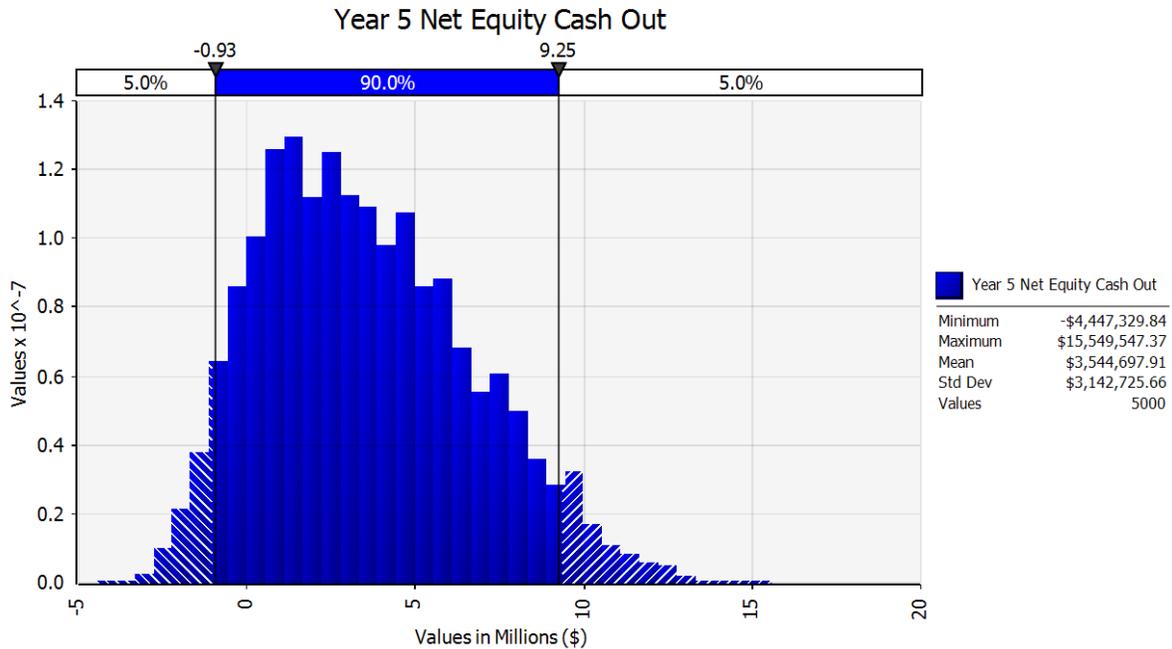


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As the charts above show, there is a 12.4% probability of zero net positive cash in year five and virtually no chance of a negative return in year 10.

The net equity cash returns are shown below. The net equity cash returns are the accumulated free cash net of the initial equity investment. The cash payout to the equity net of the initial investment is expected to be \$3.54 million if taken in year 5 and \$19.81 million if taken in year 10.



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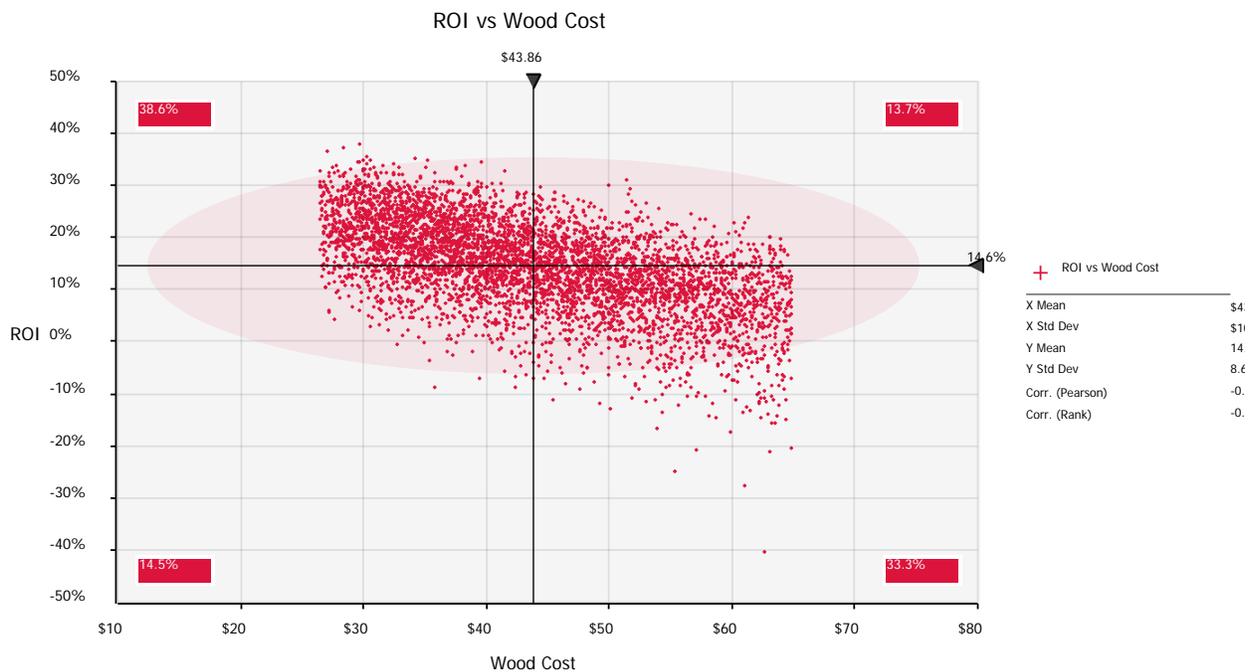
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Conclusion

This analysis has identified the key risk factors of the project. They are:

- wood cost,
- the ability for pellet prices to rise over time,
- the initial price of pellets sold from the mill,
- and the ability of the facility to run in the upper end of its name plate capacity.

The four charts below show those factors. These charts plot the ROI's from each iteration of the simulation and show the effect of each of the key factors on ROI throughout the simulation. The shaded ellipse is a 99% confidence band. The percentages in each quadrant show the proportion of outcomes in each quadrant.



This chart and the others below highlight the interdependency of the inputs. For example, in the chart above, lower wood costs, while raising the likelihood of a favorable ROI outcome, do not guarantee such an outcome. 14.5% of the simulation's iterations lie in the lower left quadrant.

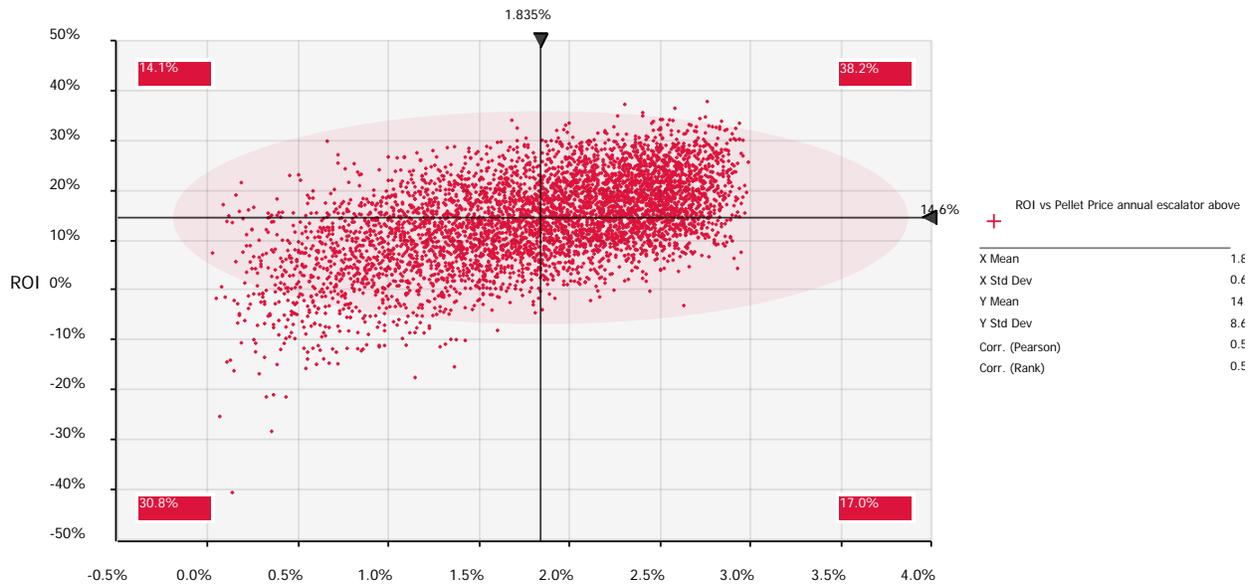
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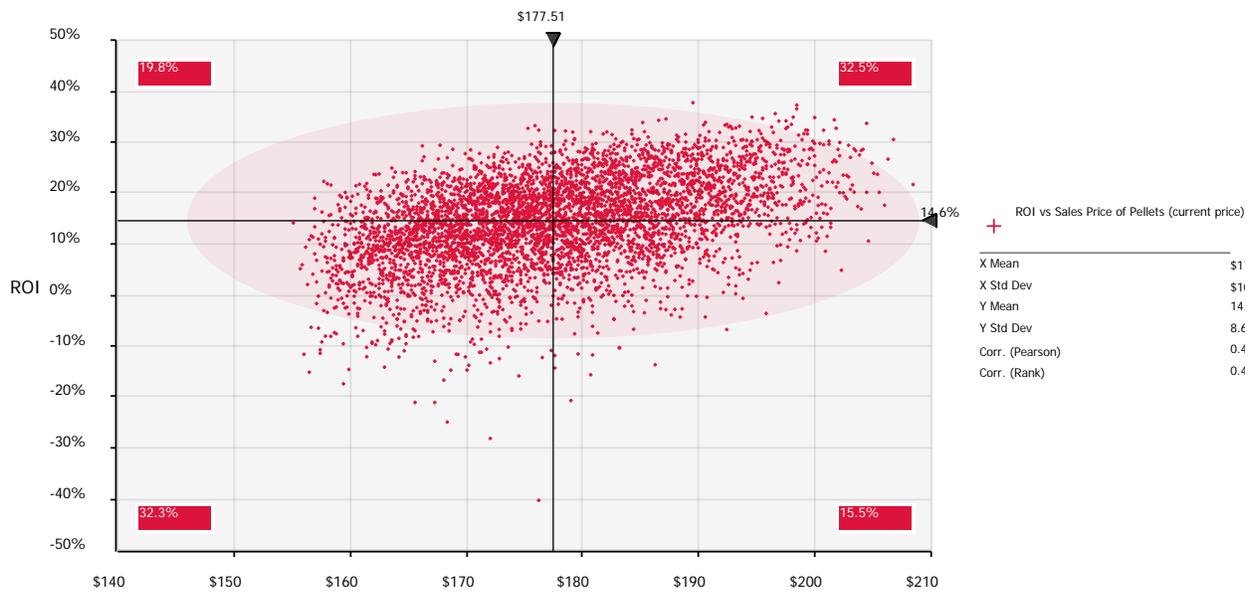
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ROI vs Pellet Price annual escalator above baseline



Pellet Price annual escalator above baseline

ROI vs Sales Price of Pellets (current price)



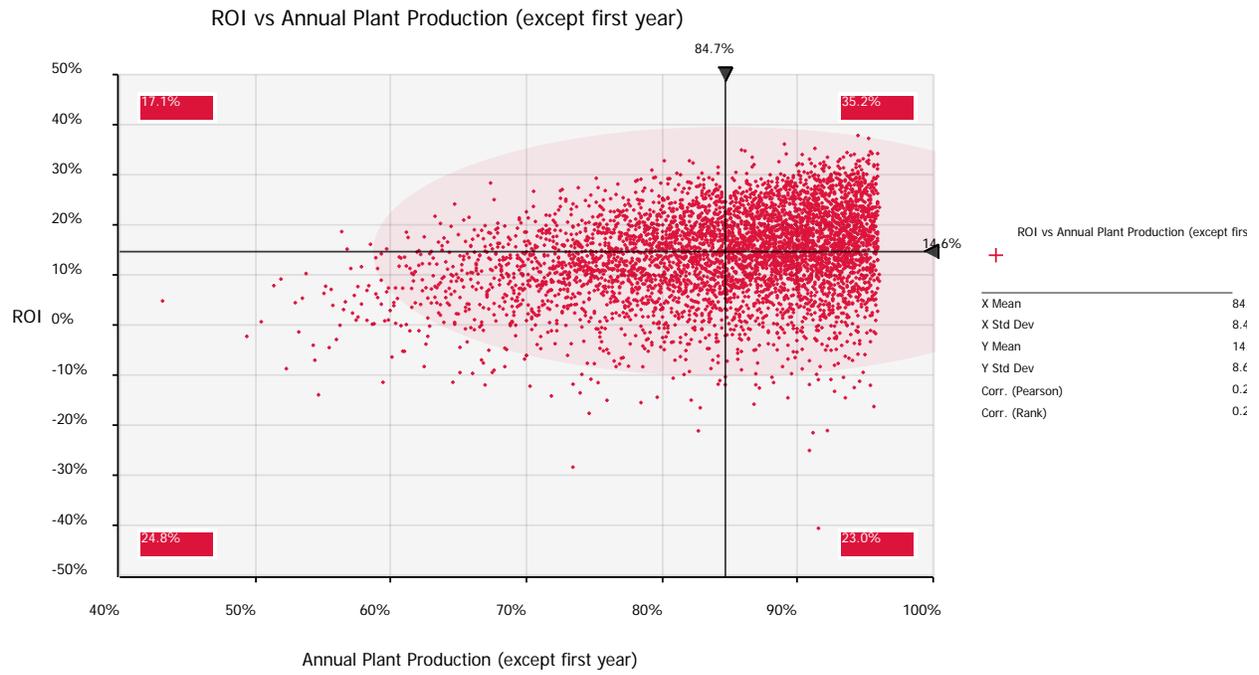
Sales Price of Pellets (current price)

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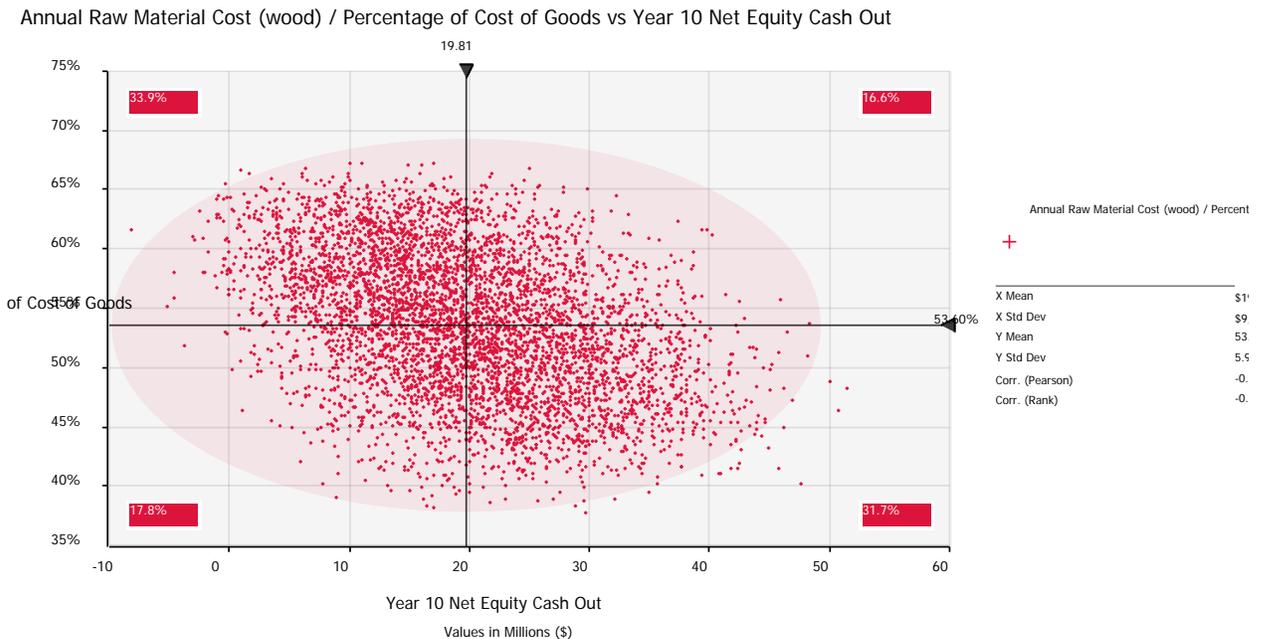


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This analysis has provided a basis for a decision on the project's validity from within the framework of the project's finances. The analysis has also provided insight into the key risk factors that influence the value of the project. Those insights provide guidance for further due diligence. These include:

- An analysis of the wood supply markets. The raw material cost is a key driver for the ability of the project to generate adequate returns on investment. The chart below shows the relationship between wood cost (as a percentage of the cost of goods manufactured) to the expected year 10 equity cash out.



- The three risk factors associated with pellet prices will require specific market analysis and forecasts.
 - The market clearing price for pellets in the region to be supplied has to be sufficient to support the project. Regional competition from other suppliers must be analyzed.
 - The demand for pellets in the region has to be congruent with the facility's nominal output specification. Excess capacity either will lower pellet prices or will lower revenues if the project operates at a diminished output. As a corollary, the design and operation of the plant has to be able to allow the facility to run safely and reliability near to its nameplate capacity for most of the year.
 - The price for pellets has to increase at a rate greater than the underlying inflation assumption of 2.5%. This is highly likely in areas in which natural gas is not a competing heating fuel. The final comments below discuss this critical assumption.

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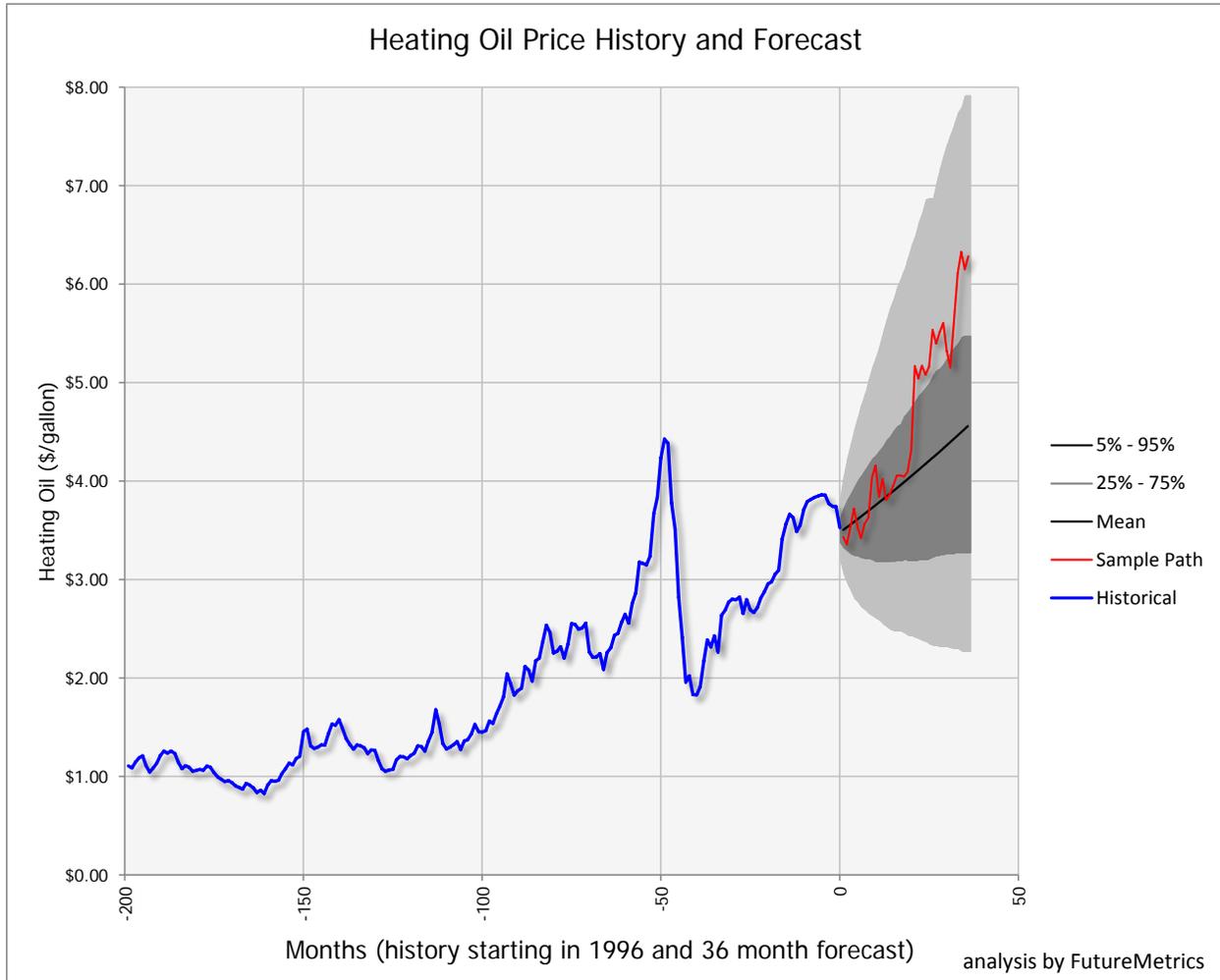


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In previous FutureMetrics research¹ we have shown that heating oil prices are expected to grow at a rate that is significantly higher than inflation and that this underlying support for the cost for heat will also allow the pellet market to increase the price of pellets at some rate higher than underlying inflation.

The chart below shows the results of an analysis of heating oil prices with one sample price path, within thousands in the simulation, highlighted in red. The forecast data varies within the Monte Carlo simulation and thus provides another quantification of risk for modeling future pellet prices.



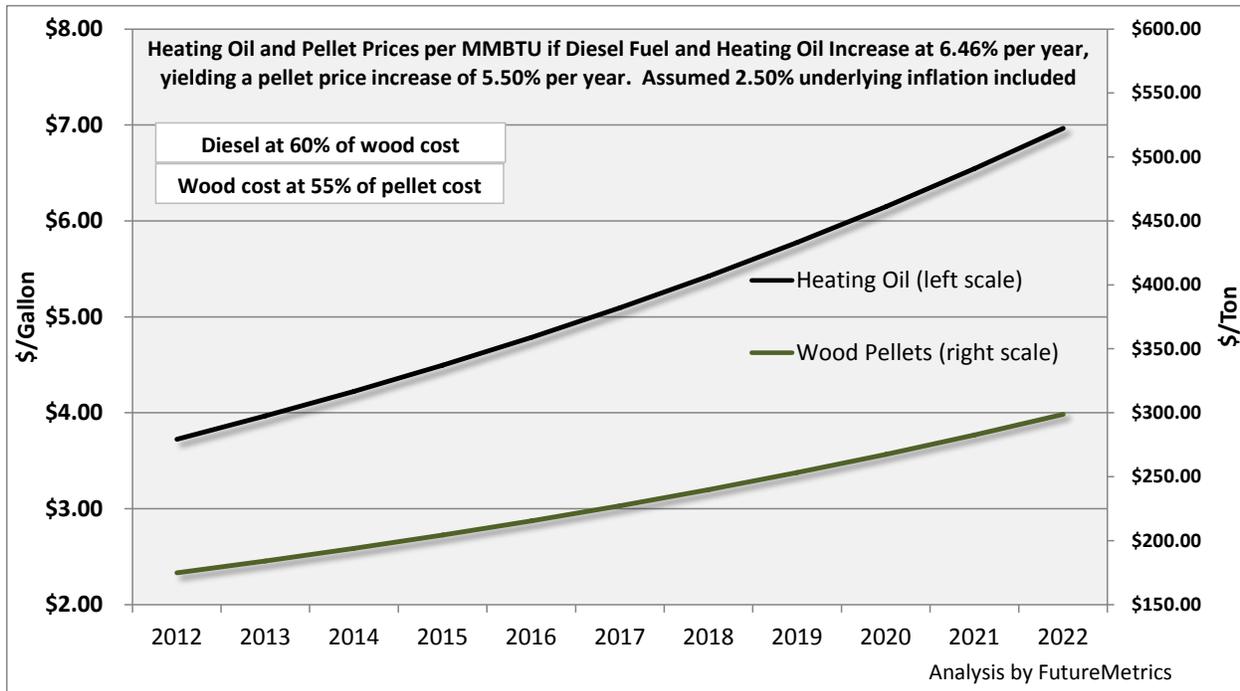
The chart below uses the historical heating oil price inflation since 2002 as the basis for the expected rate of heating oil price inflation over the next ten years. From that forecast we then forecast the expected price of pellets.

¹ See <http://www.futuremetrics.net/papers/The%20Future%20of%20Natural%20Gas%20Prices%20and%20Wood%20Pellet%20Prices.pdf>



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The risk model for the project reviewed in the body of the analysis above uses an expected pellet price inflation rate over baseline inflation of 1.8%. Based on heating oil price forecasts, we would expect pellet prices to inflate at 5.5% per year (2.5% underlying inflation plus 3.0% excess pellet price inflation). Plugging that higher value into the model lowers the probability of an ROI below 8.0% from 20.7% to 7.6%.

The region in which this project is located has no natural gas pipeline infrastructure and probably never will. Other heating solutions may compete with pellet fuel and therefore a thorough analysis of potential competing sources for heat should be a part of the decision maker's toolkit.

Final Words

This analysis has identified the key risk exposures of this project. With some attention, some of those risks can be mitigated and/or better defined. Focused attention to these key areas can then provide revised inputs.

Some of the input's interdependencies should be further studied and analyzed to define, if proven, causality behind the correlations. The model can then further refined so that the simulation sampling is influenced by these relationship.

The decision to go or no-go with the project should follow a careful review of a revised simulation based on the outcomes of the focused analysis of the markets and the key input metrics.

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